

Automated GPR Surface Scanning System for Investigation of Defects in Buried Pipes

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Ground Penetrating Radar (GPR) has proven its effectiveness in detecting buried objects. Microwaves emitted from GPR can retrieve subsurface information due to their electrical sensitivity to any changes in the medium.

In order to reconstruct an image of a buried pipe the electric fields need to be calculated and analyzed. As a proof of concept, a forward solver is used to model a ground in which a pipe is buried and a Vivaldi antenna used as an excitation source. The Vivaldi operates between 1 - 8 GHz. Different types of soils with different textures and water concentrations are considered. The pipe types include steel and PVC of radii from 1 to 5 inches. The materials transported in the pipe are varied from liquids to gases. The burial depth of the pipe is also varied from 12 to 24 inches.

A test bed is constructed consisting of a tank filled with soil and a buried pipe. Two antennas, a transmitter and a receiver, installed on automated screw rails form the surface scanning system. The two rails are controlled by two stepper motors. Two additional steppers orient the antennas at specific angles with respect to the ground's normal. The motors are controlled by National Instruments Labview software on a desktop computer via proper motion controllers.

The antennas will be connected to a HP8510C Vector Network Analyzer (VNA). The VNA sends its measurements to a desktop computer via GPIB cables. The measured complex scattering parameters are converted numerically into complex scattered electric fields using a suitable complex antenna factor. The scattered fields are input to a Level-Set reconstruction algorithm combined with frequency hopping. This algorithm is used to find the shape and any defect in the pipe as well as its location beneath the ground.

The primary goal of this work is to validate the robustness and versatility of the Level-Set method for GPR application using real data. FEKO simulations and experimental measurement results will be presented in the conference.